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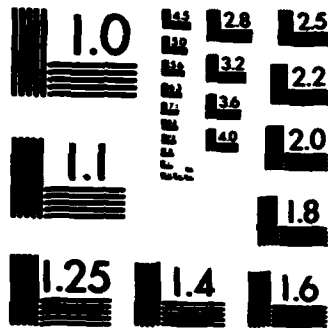
MICROCOPY RESOLUTION TEST CHART

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SOFTWARE SYSTEM - PROBABILITY OF DETECTION FOR ARTS III

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SYSTEM DESCRIPTION

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Prepared for

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FEDERAL AVIATION ADMINISTRATION
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ABSTRACT

This document describes a software technique for analyzing probability of target detection in an operational Automated Radar Terminal System (ARTS). The program provides probability of detection for various hit count distributions for the standard ARTS III data extractor. The program is run on a Digital Equipment Corporation (DEC) computer model PDP-11/20; however, sufficient information is included so that it can be adapted to other computer systems.

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INTRODUCTION

PURPOSE

The computer program described herein was developed during a field problem investigation of an Automated Radar Terminal System (ARTS) to determine the cause of excessive target loss and coasting. The technique uses extraction data from the ARTS under test and examines target reply data versus target declaration over a specified number of scans, which is further broken down into range blocks, depending on the number of scans examined and aircraft speed involved. The output data provides a probability of detection (PD) with various hit count values and provides the actual PD of the system under test. This provides the operational/maintenance personnel with valuable input data concerning performance of the overall system from the radiofrequency (RF) input to the target output.

DESCRIPTION

The PD calculations for various hit count values were provided by an ARTS III reduction program written for a Digital Equipment Corporation (DEC) PDP-11/20 computer. The program is capable of accepting a particular beacon code and reporting the actual PD of the aircraft for a selected number of scans. It can also report the PD based upon the number of replies received for the test aircraft (hit count), and system parameter values from 3 to 24 hits for target declaration.

The program requires that the user input the 3/A code of the target whose PD calculations are desired. The program reduces data on a scan basis by searching azimuth words for north transition. The software is programed to skip scans on the extraction tape to start processing data later in the tape. The number of scans to skip and the number of scans to process are user input parameters, as are the range and azimuth boundaries. These capabilities are required since buffer sizes (for storage of replies) for the whole scan would be quite large. The program at the Federal Aviation Administration (FAA) Technical Center provides 1,000 memory locations for the storage of replies; therefore, the range-azimuth boundaries should be selected which limit the amount of aircraft processed on a particular scan to approximately 30. This buffer size allows range-azimuth boundaries which adequately cover the flight pattern of any aircraft for a large number of scans. The buffer size can be made any size and, if memory allocations permit, the buffer can be enlarged to process the whole scan. Other limitations of the program are its inability to report on discrete codes unless range-azimuth boundaries are picked to assure no other aircraft of the same code are processed.

The program calculated PD as follows:

1. All replies within the range-azimuth boundaries are stored in a temporary buffer. The buffer contains the range, mode, code, and a sweep number. The sweep number is determined by counting the azimuth words, labeling the first processed azimuth word one; the replies are stored until azimuth stop value or north mark is reached.

2. At north transition, the number of replies received for the selected target are counted. This is done by searching for the first ungarbled mode 3/A reply matching the mode 3/A code selected (first found reply).

3. The sweep number and range of the reply are stored and the program searches the buffer backwards for any range correlated replies (within ± 1/16 nautical mile of the selected target reply range). The search for replies continues until: (a) The beginning of the buffer is reached, or (b) a range match is found whose sweep number, compared to the previously found reply's sweep number, is greater than a preselected value. This preselected value should be large enough to insure that the end and beginning of the target are accurately declared. It can be made equal to the miss parameter MY4R of the ARTS system to simulate the same detection process as the ARTS. Therefore, if the ARTS system misses replies belonging to the selected aircraft because a large number of missed sweeps occurred in the middle of the target, this program will also follow this pattern and report the same information. The program at the Technical Center contains a value of 10 for missed replies, but this varies with application. If a range match is found and the sweep number of the reply, as compared with the previous reply's sweep number, is zero the reply is a range split and is ignored. Every reply found that meets the above criteria increments the hit count for the target.
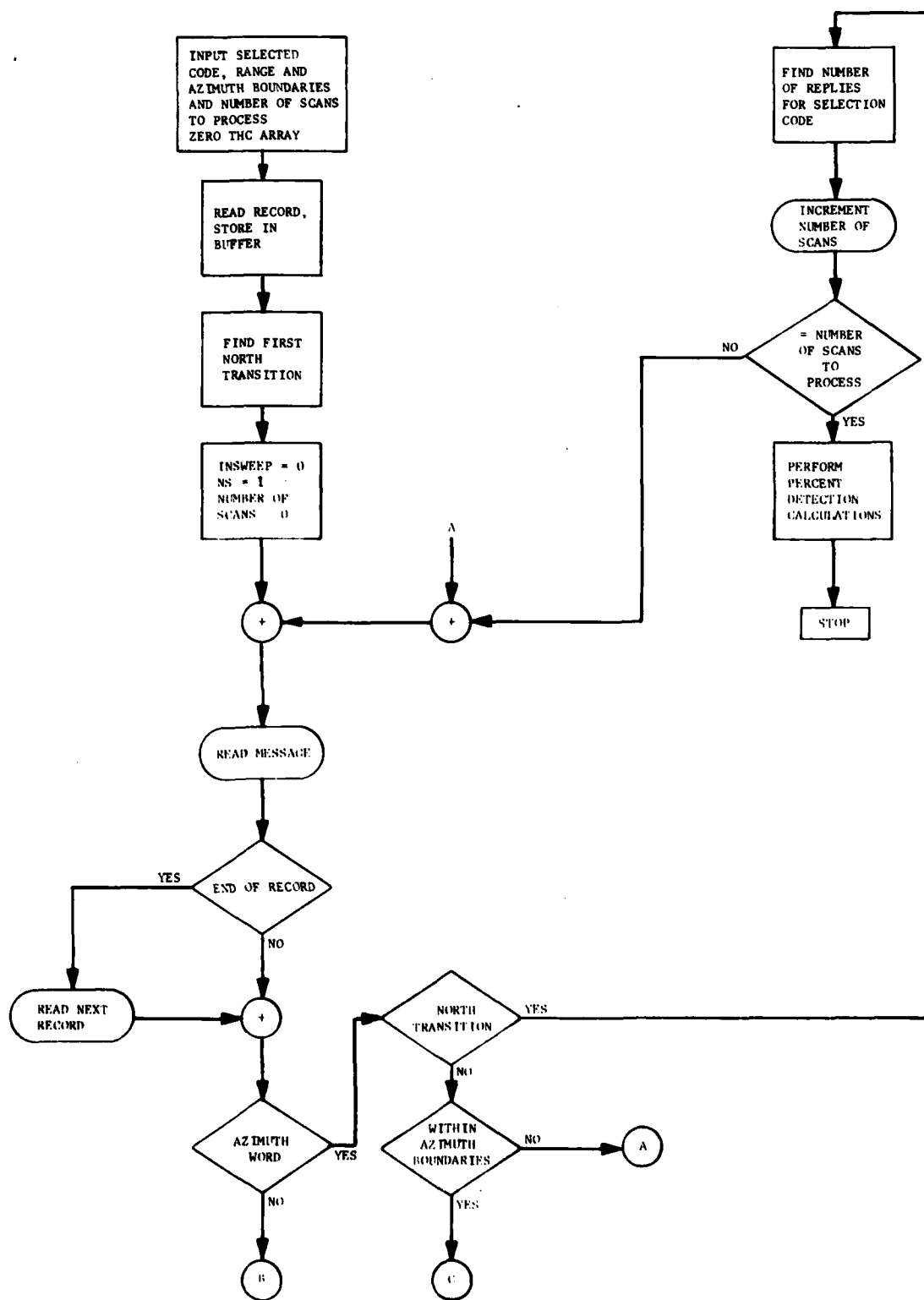
4. After searching the buffer in reverse, from the first found reply to the beginning of the buffer, the buffer is searched in the forward direction from the first found reply, and the hit count incremented for each correlated reply.

5. The final hit count gives the number of replies received for the selected aircraft for the given scan. The hit count value N for a scan will increment all elements of an array less than or equal to N. This array (labeled THC in the flow chart) represents the number of scans the target would have been detected if the hit count surpassed the index of the array element.

6. After the number of scans equals the selected number of scans to process, each element of the above array is divided by the number of scans searched, thus representing percent detection PD.

The actual detection probability (number of scans the ARTS III will output per target for the selected aircraft divided by the number of scans searched) is also calculated. It should closely match the PD for the hit count value representing the ARTS III parameter HY4R.

Enclosed is a flow diagram (figures 1 - 5) of the program at the Technical Center. It can be implemented on a different computer, if desired. Any existing programs which presently reduce ARTS III data reduction tapes could be modified to include the above capability.
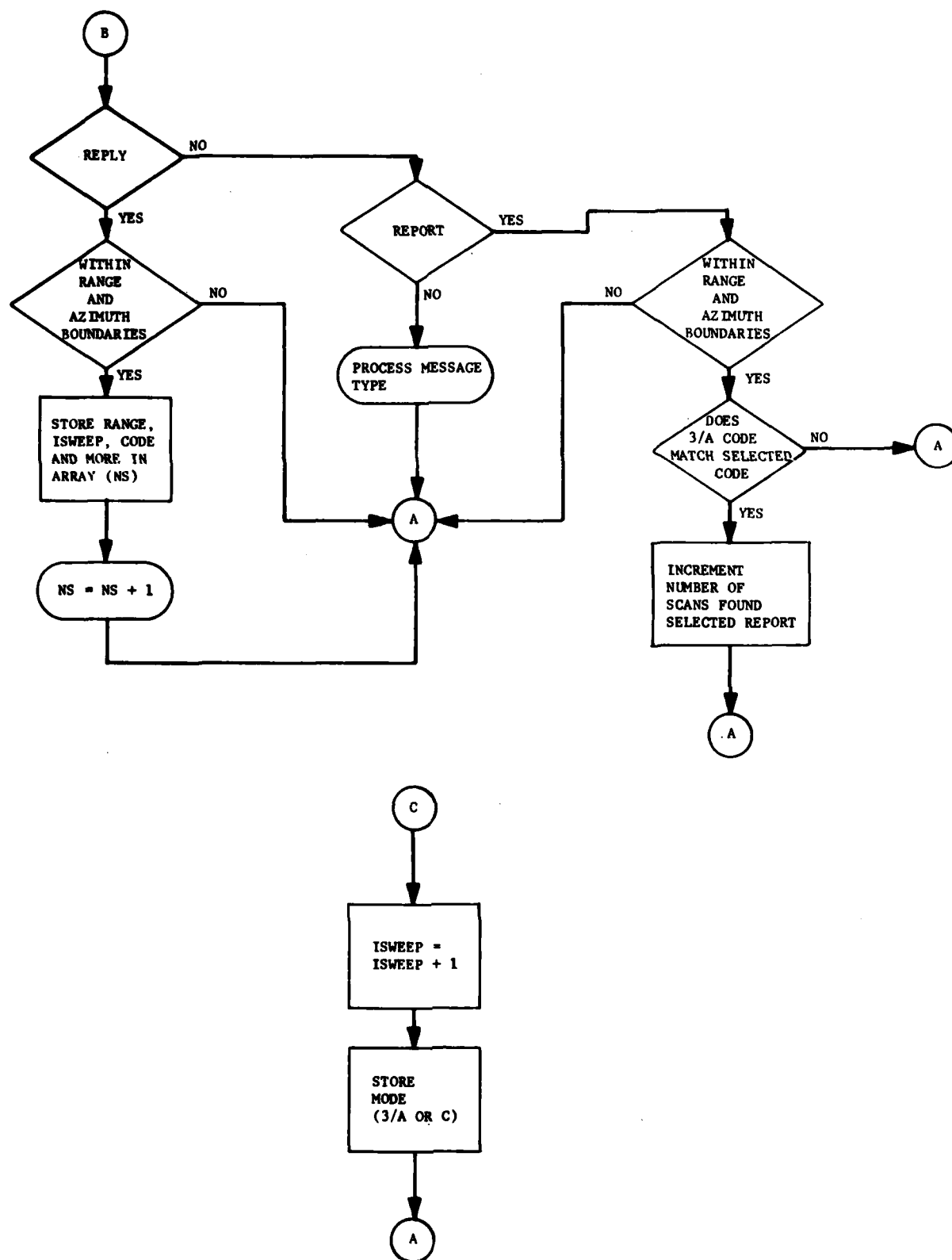
INPUT SELECTED
CODE, RANGE AND
AZIMUTH BOUNDARIES
AND NUMBER OF SCANS
TO PROCESS
ZERO THC ARRAY

READ RECORD,
STORE IN
BUFFER

FIND FIRST
NORTH
TRANSITION

INSWEEP = 0
NS = 1
NUMBER OF
SCANS = 0

READ MESSAGE

END OF RECORD

YES

NO

READ NEXT
RECORD

AZIMUTH
WORD

YES

NO

B

FIND NUMBER
OF REPLIES
FOR SELECTION
CODE

INCREMENT
NUMBER OF
SCANS

= NUMBER
OF SCANS
TO
PROCESS

NO

YES

PERFORM
PERCENT
DETECTION
CALCULATIONS

STOP

A

NORTH
TRANSITION

YES

NO

WITHIN
AZIMUTH
BOUNDARIES

NO

A

YES

C

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FIGURE 1.   INPUT/INITIALIZATION
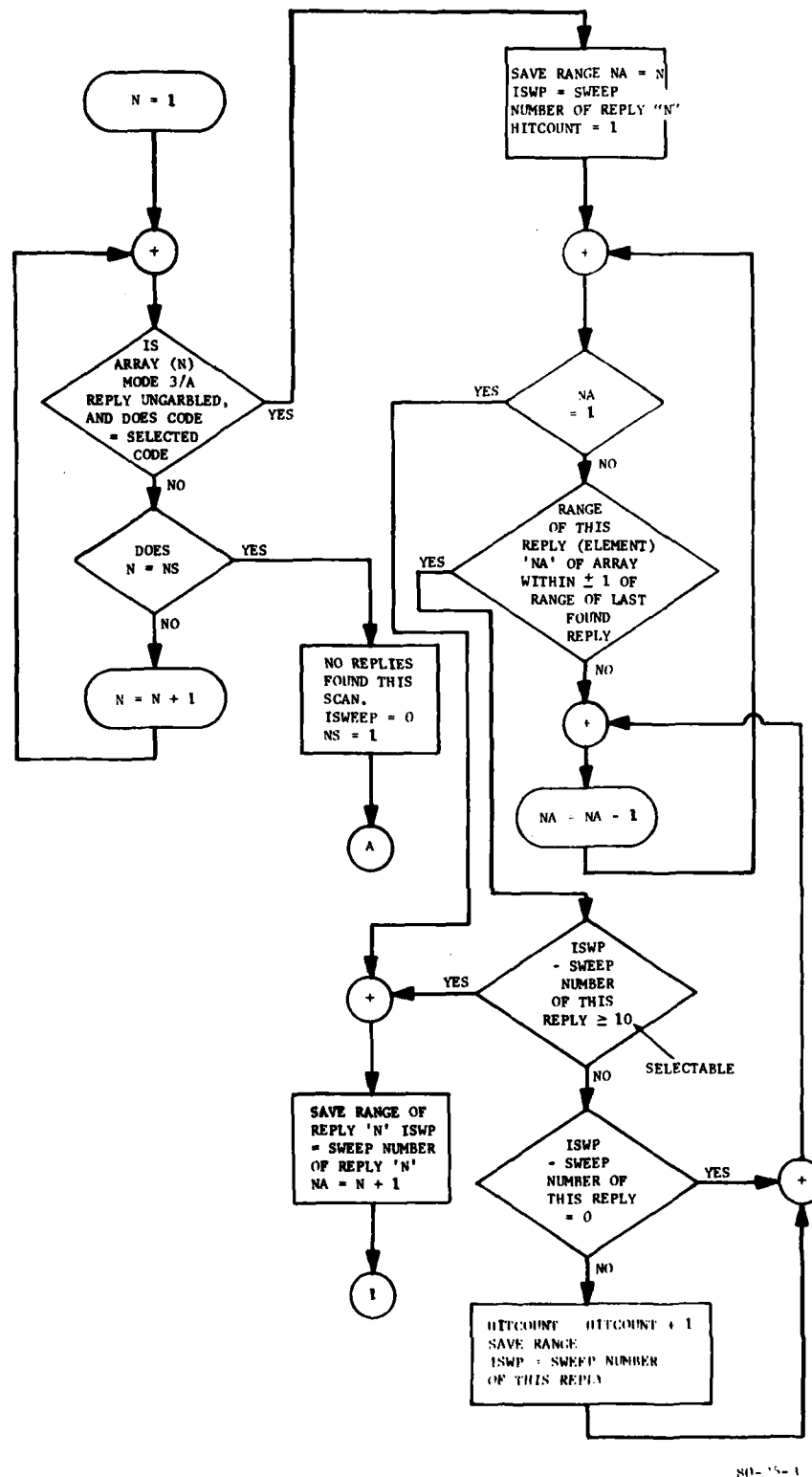
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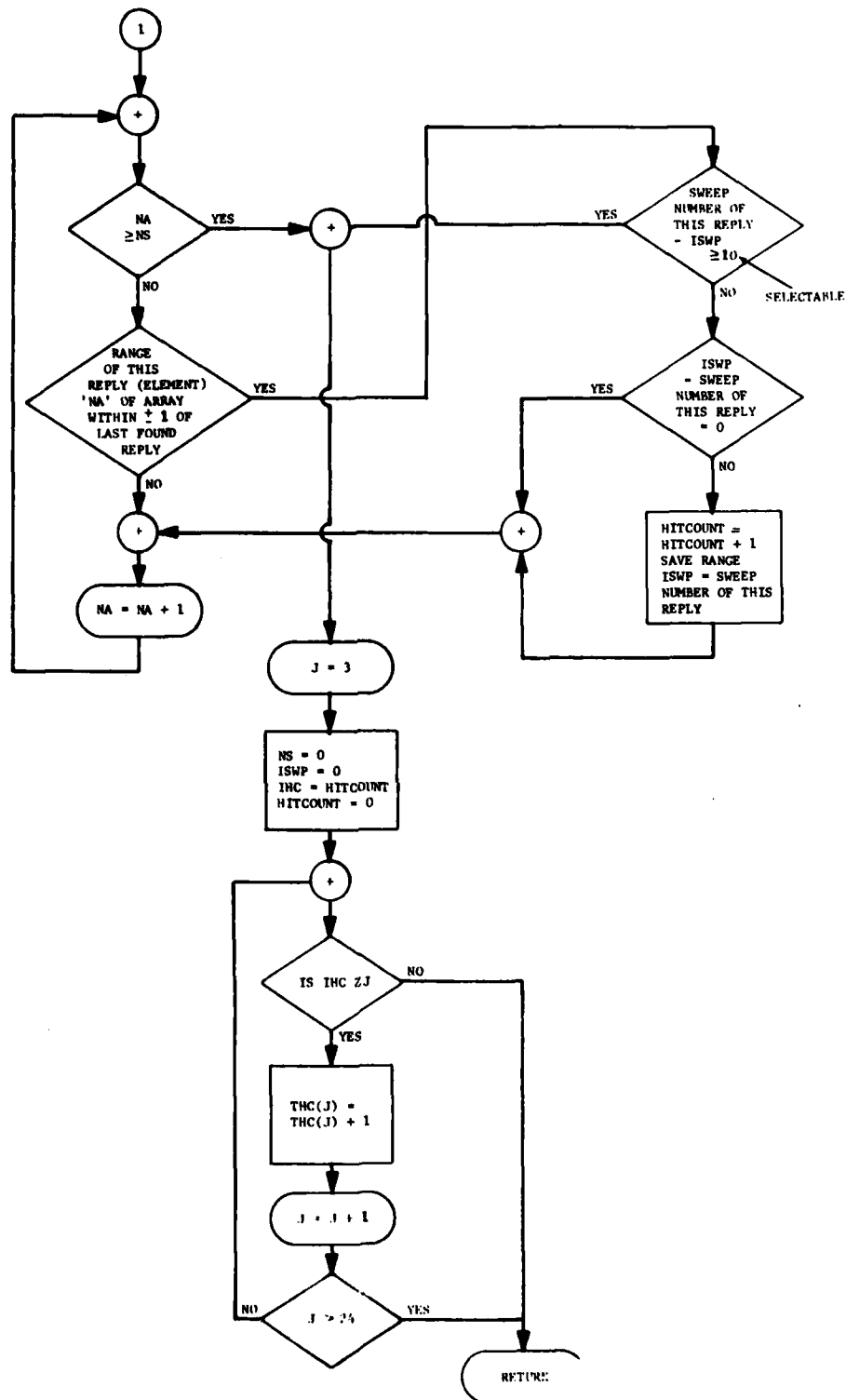FIGURE 2. CODE MATCH

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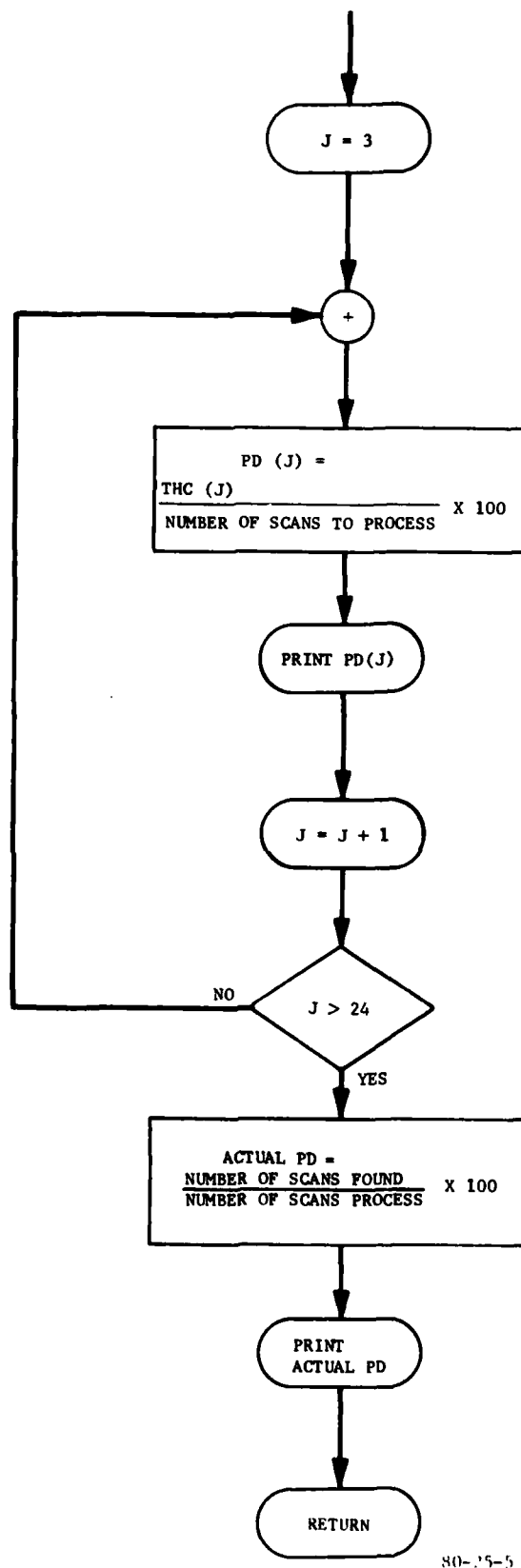FIGURE 3. SELECTED CODE HIT COUNT

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FIGURE 4. RANGE CORRELATION

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FIGURE 5. PD CALCULATION

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